



## **Investigation of Isovaline Enantiomeric Excesses and Other C5 Amino Acids in Carbonaceous Meteorites**

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The origin of biological homochirality is one of the most perplexing puzzles to understanding the emergence of life on Earth. While many models have been proposed (e.g. Hazen et al. 2001; Keszthelyi 1984), the only reported non-biologically generated compounds that show a significant enantiomeric excess are a few amino acids in the CM2 Murchison and Murray meteorites (e.g. Pizzarello and Cronin 2000; Pizzarello et al, 2008).

Of these isovaline ( $\alpha$ -ethyl-alanine) is of particular interest since it is typically abundant in CM2 meteorites, is exceedingly rare in biology, and due to its chemical structure is likely to maintain its primordial D/L ratio.

Instead of the gas chromatography-mass spectrometry (GC-MS) technique employed by Pizzarello et al., we have used liquid chromatography-fluorescence detection/time of flight-mass spectrometry (LC-FD/ToF-MS) to study the enantiomeric ratio of isovaline in the CM2 meteorites Murchison and LEW90500 and the CR2 QUE99177. We have placed particular emphasis on understanding the suite of C5 amino acids in these meteorites. In doing so, we have determined that D and L 3-aminopentanoic acid co-elutes with L-isovaline and L-valine under common chromatographic conditions (Glavin and Dworkin 2006) for *o*-phthaldialdehyde/N-acetyl-L-cysteine (OPA/NAC).

We have devised a method to separate these compounds and we will report the actual D/L ratios of isovaline in these meteorites and how they compare to the GC-MS measurements of Pizzarello and co-workers.

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